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1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

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UTILISATION OF UNUSED PROTEIN RESOURCES FOR HUMAN FEEDING

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1. The significance of protein malnutrition in developing countries

The unfortunate social and economic consequences of under-nutrition and malnutrition in large segments of the populations of the developing countries are now clearly recognized. The consequences of impairment of nutritional health may include lowered vitality, impaired intelectual and physical productivity, increased susceptibility to diseases, and other undesirable manifestations. In spite of this general recognition of the importance of satisfactory nutritional status, the extent to which under-nutrition and malnutrition of infants and young children is related to an inadequacy of the supply or use of protein-rich foods does not seem to have been adequately appreciated. This problem is particularly acute in the tropical and sub-tropical areas. Nutrition research has shown a direct connection between protein inadequacy in the diets of weanlings and toddlers and the very high death rates of children in the one to four year age group in several countries. The probability that much more can be done to meet these needs by pressing into use local protein resources now not used as food also merits wider recognition.

Increased comprehension is needed at planning levels of governments, that the general assurance of adequate nutritional status cannot come about by placing emphasis solely on increased production of traditional calorie-rich staples such as maize, rice, cassava, bananas or even wheat. Infants and young children experience the most rapid stage of human growth, thus requiring dietary protein for tissue building of a quantity and quality considerably in excess of that provided by diets restricted to these common food staples. The supplementation of these diets by animal protein, - best of all milk, - and by pulses is most desirable. However, a major problem in many tropical and sub-tropical countries is that such foods may be in short supply and the possibility for augmenting their production may, for various reasons, also be limited or be, at least, a slow process.

2. The problem of low-protein food staples

A clearer understanding of the problem can be gained by examining the protein levels of the world's primary foods, with particular attention to the staples used in the tropics and sub-tropics as shown in Table 1.

Table 1. Average Protein Content of Selected Foods

(Expressed as percent, N x 6.25, air dry or "as processed")

Foods of animal origin		Cereals	
Whole milk	26.1	Wheat flour	11.5
Skim milk	35.0	Rice (brown)	7.2
Beef	64.8	Rice (polished)	7.0
Whole egg	47.0	Maize meal (whole)	9.4
Cod, salted	81.8	Maize meal (degerm.)	7.9
		Sorghum meal	8.8
Oilseeds and pulses			
Broad bean	24.0		
Chickpea	18.2	**Starchy roots and fruits**	
Garden pea	22.5		
Kidney bean	22.0	Cassava (manioc)	1.7
Lentils	23.7	Potato	6.4
Peanuts	26.7	Sweet potato	1.6
Sesame seed	17.6	Banana	1.8
Soybeans	33.4	Plantain	2.8

The widely used "weaning foods" such as cassava, bananas and sweet potatoes are extremely low in protein. Even the major cereals, rice, maize and wheat do not provide adequate levels of protein, either in quality or quantity, within the maximum levels which weanlings and toddlers can consume.

It has always been true that the total consumption of protein, and indeed the percentage of high quality protein from animal sources, varies with family and economic status. At the national level, it also varies with the degree of economic development. This relationship is shown in Table 2.

Table 2. Average Calories and Proteins Available per Person per Day, 1958-59

Developed countries	Calories	Proteins	
		Total, g	Animal, g
Australia	3200	91	60
United Kingdom	3260	85	50
United States	3100	93	65
Under-developed countries			
India	1800	47	6
Mexico	2250	58	13
U.A.R.(Egypt)	2590	77	15

3. New protein resources

It is for these reasons that considerable interest is being directed towards utilising as food in countries chronically deficient in animal protein the indigenous protein resources such as the oilseed meals and presscakes as well as fish flour, all of which have been little used previously as human foods. The widespread availability of these materials, particularly in many tropical and sub-tropical countries, suggested to food authorities that these protein resources could be brought into use as economical protein supplements well in advance of more novel and longer-range possibilities such as the proteins from algae, yeast, green leaves, mushroom mycelia and plankton, for which adequate technology does not now exist.

The protein-rich residues of peanut, cottonseed, soybean, sesame and copra (desiccated coconut meat) have been traditionally used as fertilizers or as animal feed. The proposal that they be utilised as foods for infants and children, notwithstanding the extensive literature on their feeding value for animals, prompted searching questions from human nutritionists and pediatric clinicians. These doubts have now been mostly dissipated as a result of a five-year international research programme assisted by the Rockefeller Foundation. Last year, the research reports of 26 nutrition research workers and their pediatric collaborators were published indicating the remarkable usefulness of plant proteins in infant and child feeding, particularly when they are combined with each other and with the locally used calorie-rich staple foods to produce the best possible amino acid patterns. Based on these and other clinical and nutritional studies, practical feeding programmes have been already initiated in several countries. Oilseed protein residues are being used in most of these programmes. Continuing surveillance of the clinical, pediatric and food safety aspects of the programme is provided by the WHO/FAO/UNICEF Protein Advisory Group, a committee of internationally recognized nutritionists, clinicians and pediatricians. This Group, in cooperation with specialists in many countries, evolved a number of criteria for processed high-protein foods which include the following requirements:

(a) the material used must be available locally or be suitable for local production;

(b) the purchase of the processed food must be within the economic means of the particular population group requiring it;

(c) they must be easily transportable and have a long storage life under tropical conditions;

(d) they must be free of any toxic or other deleterious influence;

(e) they must have such nutritional value as to be an effective protein supplement; and

(f) they must be acceptable to the local population.

4. The possible impact of oilseed residues on protein needs

The quantitative role which oilseeds might play in meeting the world's protein food shortage is indicated in Table 3 which presents a recent estimate of world oilseed production. Soyabean, cottonseed and peanut are the largest

Table 3. World Production of Oilseeds, 1958

	Million tons
Soybeans	28
Cottonseed	19
Peanut	14
Copra	3
Sesame	2
Sunflower	2

oilseed crops. The potential nutritional impact of some of these resources in specific under-nourished countries where they are available is indicated in Table 4.

Table 4. Oilseed Protein potentially available

grams/person/day

Peanuts		Cottonseed		Copra	
Nigeria	10	Egypt	17	Philippines	6
India	5	Mexico	13		
		Brazil	8		
		Turkey	6		

The impact can be best estimated on the basis of optimum human protein requirements which have been suggested to range from 40 to 70 grams per person per day.

5. The role of Governments and WHO/FAO/UNICEF in protein-rich food Projects

In order to assist interested Governments to initiate, organize and carry forward protein-rich food programmes based on wider utilisation of local protein resources, the United Nations Agencies WHO, FAO and UNICEF initiated some eight years ago a joint programme to co-ordinate, develop and disseminate available nutritional and technological knowledge in this field. Through this programme, material assistance is available to Governments for acceptability testing and local processing of suitable foods as well as for their introduction into national food economies. Within the framework of a UNICEF/FAO-assisted protein-rich foods programme, specialized training of government-sponsored scientists can be provided, and the services of international advisors to assist the national effort can be furnished.

It is the responsibility of Governments to initiate such programmes by requests through the usual channels. A responsible Government agency must be prepared to assume active leadership of a broad national scheme which would include the co-ordinated efforts of local industry, extension services, welfare agencies and voluntary organizations. These programmes are aimed at establishment of acceptance and development of continuing demand for protein-rich foods by the people. One of the ultimate objectives of course is to make such products available to low income families through normal marketing channels.

6. Progress in the utilisation of oilseed and fish protein concentrates

One of the most encouraging prospects is the wider utilisation of soybean as a protein resource. In Indonesia, UNICEF and FAO have assisted the Government to bring into operation a plant producing a spray-dried extract ("milk") from soybean and sesame, known locally as Saridele, which has gained good acceptance and an increasing demand. This plant is now operated commercially. Much attention is being given in Taiwan, Brazil and Indonesia to the development of new soy food formulations with heat-processed full-fat whole-soybean products which appear to be of higher nutritional value and lower in cost of production than the extracted spray-dried beverages. UNICEF is also sponsoring research and development to improve the technology of certain traditional fermented soy foods, including tempeh, a mould-processed product popular in Indonesia, which may be also useful for the production of infant foods. The composition of some typical dry soy food products, including one of the new isolated protein materials, is shown in Table 5.

Table 5. Composition of some typical dry soy foods

	Beverage powders				
	Defatted heated soy flour	Full-fat heated soy flour	Based on full-fat soy flour	Saridele	Protein isolate
Protein (N x 6.25),%	52.0	43.0	29.0	29.1	88.5
Fat, %	1.5	22.0	16.0	18.2	0.1
Fibre, %	3.2	2.0	1.6	0.5	0.7
Ash, %	5.8	4.2	5.0	4.2	2.4
Carbohydrates, %	33.2	25.0	45.0	44.0	-

Food-grade defatted peanut flour also offers considerable potential. UNICEF is presently assisting the Government of India to bring into production the first commercial plants to provide edible peanut flour with protein content of 45% or more. The major application will be as a supplement to wheat flour and for infant food formulations. In Nigeria, peanut flour supplemented with skim milk (4:1) is being introduced and has been shown to have nutritive and therapeutic value essentially equivalent to that of skim milk in treatment of kwashiorkor. In Senegal, FAO and UNICEF are co-operating in the promotion of millet foods supplemented with locally produced peanut flour. Brazil also has achieved considerable production of peanuts, and a solvent-defatted locally made product has been utilised in school lunch feeding.

Recently, toxins of fungal origin have been shown to occur in some lots of low-grade animal and fertilizer-grade peanut presscakes moving in international commerce. This observation has raised considerable apprehension concerning the safety of peanut foods. Fortunately, techniques have been developed in British laboratories to screen peanuts for freedom from this factor. FAO and UNICEF are reacting to this problem by providing training grants to scientists involved in national efforts to process and introduce peanut flour as food, in order that they may initiate such screening methods in their home countries. This will permit full resumption of these introductory and food promotion efforts. Some chemical analyses of peanuts, peanut flours and protein isolates from peanuts are indicated in Table 6.

Table 6. Results of Chemical Analyses of Peanuts, Peanut flours and Protein Isolates of different origin

Source	Process	Moisture %	Protein N x 6.25 %	Fat %	Ash %	Crude Fibre %
Peanuts						
Senegal	-	5.5	26.8	41.7	2.1	5.4
Flours						
Georgia, USA	Expeller	8.6	52.6	5.6	4.3	3.6
Senegal	"	7.4	43.9	4.5	3.4	4.3
India	"	10.0	46.0	8.0	5.0	2.1
Brazil	Solvent	5.4	63.5	3.1	4.6	3.3
Isolates						
Mysore, India	Dispersion	4.7	90.0	4.2	1.1	-
B.C.and C., UK	Impulse	8.0	93.0	1.0	1.5	-
"Lypro", UK	"	3.0	68.0	27.0	1.0	-

Suitably processed cottonseed flour is already finding acceptance in food mixtures in Central and South America. This progress is mostly the result of the pioneering nutrition and food formulation efforts of the Institute of Nutrition of Central America and Panama (INCAP). Table 7 shows typical chemical values for

Table 7. Composition of some Cottonseed Protein Products

	Edible defatted flour	Solvent-degossypolized meals		INCAP formula 9B
		Sicily	U.S.	
Protein (N x 6.25), %	51.3	54.1	51.0	27.5
Fat, %	5.2	1.0	0.6	4.2
Fibre, %	3.7	4.3	7.1	2.4
Ash, %	6.6	-	7.0	3.5
Carbohydrates, %	30.0	-	24.4	54.8
Total gossypol, %	0.92	0.26	0.1	-
Free gossypol, %	0.045	0.03	0.03	-
Lysine				
Total, % of protein	4.1	-	-	3.5
Available, % of protein	3.6	3.4	3.1	-

various cottonseed products processed as food, as well as that of Incaparina (Formula 9B) which is a low-cost mixture of expeller-processed edible cottonseed flour, corn and mineral and vitamin additives which has been used with remarkable effectiveness in treating protein malnutrition in infants and children. The success of this clinical experience has established the acceptability as food for infants of cottonseed products processed so as to largely inactivate or bind the

free gossypol which is normally considered to be toxic. UNICEF and FAO are currently fostering food development and acceptability studies with cottonseed flour in Peru, Pakistan, Egypt, Turkey and Iraq, which will hopefully lead to local production and expanded use of this protein concentrate.

The possibility of producing low-cost stable, bland, deodorized fish flours from whole fish in various parts of the world to provide a highly nutritious protein supplement for calorie-rich staples such as bread and noodles is now very real. Thus UNICEF has recently assisted the Government of Chile to bring into production a plant delivering about one ton of fish flour per day. This product contains about 80% protein and thus has excellent nutritional value. FAO has been assisting the Government of Morocco in the market promotion of a similar product produced in that country. The chemical and nutritional characteristics of several defatted, deodorized bland fish flours as produced from whole fish in Morocco, Sweden and Chile, are shonw in Table 8. Similar products have also been made in South Africa, Canada and the United States.

Table 8. Characteristics of some defatted bland Fish Flours

	Morocco	Sweden	Chile 1	Chile 2	Chile 3	Chile 4
Moisture, %	5.3	3.4	8.2	5.9	7.6	5.0
Protein (N x 6.25), %	81.4	86.3	79.8	80.4	78.6	81.6
"Fat"						
by Acid hydrolysis %	2.6	3.6	2.5	3.0	3.1	1.6
Ethanol extractables %	-	2.5	1.3	2.1	1.8	1.6
Ash %	12.8	13.4	14.7	16.8	16.5	18.1
Acid-insoluble ash, %	-	0.1	0.2	0.3	0.2	0.2
Crude fibre, %	-	0.4	0.4	-	-	-
Fluoride, p.p.m.	-	-	150.0	-	201.0	-
Lysine						
Total, % of protein	-	-	8.8	-	9.0	-
Available, % of protein	9.0	6.9	7.9	7.7	8.0	7.5
Nutritive value of protein						
P.E.R. *	2.7	-	3.0	2.7	-	2.8
N.P.U. **	72.0	-	79.0	79.0	74.0	80.0

* Protein Efficiency Ratio
** Net Protein Utilization

UNICEF is currently fostering technological studies aimed at the recovery of sanitary, protein-rich flours from sesame, sunflowerseed and cocomut. These latter studies are not as far advanced as those of other oil-bearing protein-rich seeds, nevertheless there is good reason to expect the early development of practical manufacturing technology for these products. An example of a protein-rich cocomut flour produced by screw-pressing is shown in Table 9.

Table 9. Composition of Screw-Press produced, defatted Coconut Flour

	%
Moisture	5.3
Fat	10.1
Protein (N x 6.25)	18.8
Ash	5.2
Crude fibre	9.4
Carbohydrate	51.2

Headquarters staffs of UNICEF, FAO, WHO as well as their field representatives are always pleased to receive enquiries from representatives of Governments and industry, as well as from scientists, clinicians and voluntary agencies, for further information about this new programme. Co-operative efforts to bring into regular dietary use many of the existing protein materials currently unavailable as food can go a long way towards solving protein deficiency problems in many countries, and may also be useful in meeting the food needs of the world's rapidly growing population.

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